Assessing Wind extremes in Mediterranean ports with EURO-CORDEX simulations

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Introduction

- Under climate change, more extreme events are expected, particularly in the Mediterranean region, and adaptation is key to reduce the impacts in our society.

- Understanding how these events will be in the future is key to support climate adaptation.

- Harbours are at the center of economy, the door for goods.
  The Mediterranean sea transportation is one of the most important in the world. It is crucial to implement adaptation measures to protect ports, in particular, against strong winds that can humper crains.

Socio-economic relevance

Support climate adaptation and mitigation planning

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Socio-economic relevance

Support climate adaptation and mitigation planning

Provide regional climate projections under different emission scenarios, allowing for regional action

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Provide regional climate projections under different emission scenarios, allowing for regional action

Enable applications, such as resilient infrastructure design, and risk estimation

Support the decision making of local authorities, by predicting the climate impact of their decisions

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Extremes

- Return periods are used to estimate the probability that an extreme event occur.

Coordinated Regional Climate Downscaling Experiment (EURO-CORDEX)

- It is a **global initiative** led by the WCRP (World Climate Research Programme)
  - Provides **high-resolution regional climate projections** by downscaling global climate models⟶ fine-scale information for local impact assessments
  - It provides multi-model climate simulations based on **both historical and future emission scenarios**
- **Spatial resolutions** of 50km, 25km and 11.5km.

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Aim

GENERAL OBJECTIVE:

Conduct an extreme-value analysis of near-surface winds in Malaga using EURO-CORDEX simulations

SPECIFIC OBJECTIVE:

Estimate return levels for historical and future horizons, comparing results from raw and bias-corrected datasets

SCIENTIFIC QUESTIONS:

- How do return levels of extreme winds evolve across scenarios and time horizons?
- What is the impact of bias correction on the estimated extremes?
- What are the implications for climate resilience and port infrastructure planning?

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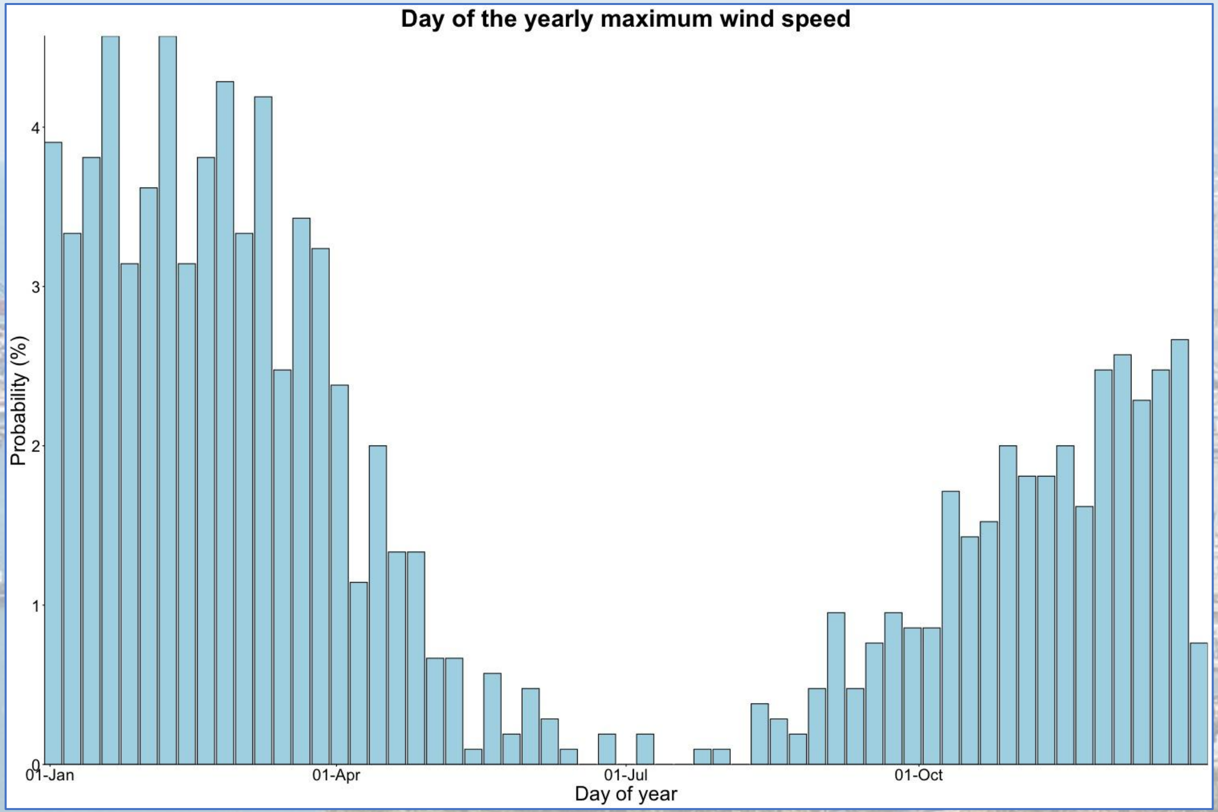
Selected Area



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The dataset

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MODELS

6 different models – raw+bias corrected

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HISTORICAL BASELINE

1976-2005 daily data

The dataset

MODELS — 6 different models – raw+bias corrected

HISTORICAL BASELINE — 1976-2005 daily daily

FUTURE PROJECTIONS — 2036-2065 (mid-century) – 2066-2095 (long-century)

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The dataset

MODELS	6 different models – raw+bias corrected
HISTORICAL BASELINE	1976-2005 daily data
FUTURE PROJECTIONS	2036-2065 (mid-century) – 2066-2095 (long-century)
SCENARIOS	IPCC RCP 4.5 and 8.5 scenarios

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The methodology

Bias correction data

Extreme-value analysis:

- Return periods computed by block maxima
- Compute the yearly maximum value
- Adjust the yearly maximum to Gumbel distribution

$$F(x) = \frac{1}{\alpha} e^{-z-e^{-z}} \qquad z = \frac{x-\beta}{\alpha}$$

α=scale

β=location

- Compute the return period

$$U_T = \{\beta + \frac{\alpha}{k}\left\{1 - \left[-\ln\left(1 - \frac{1}{T}\right)\right]^k\right\}$$

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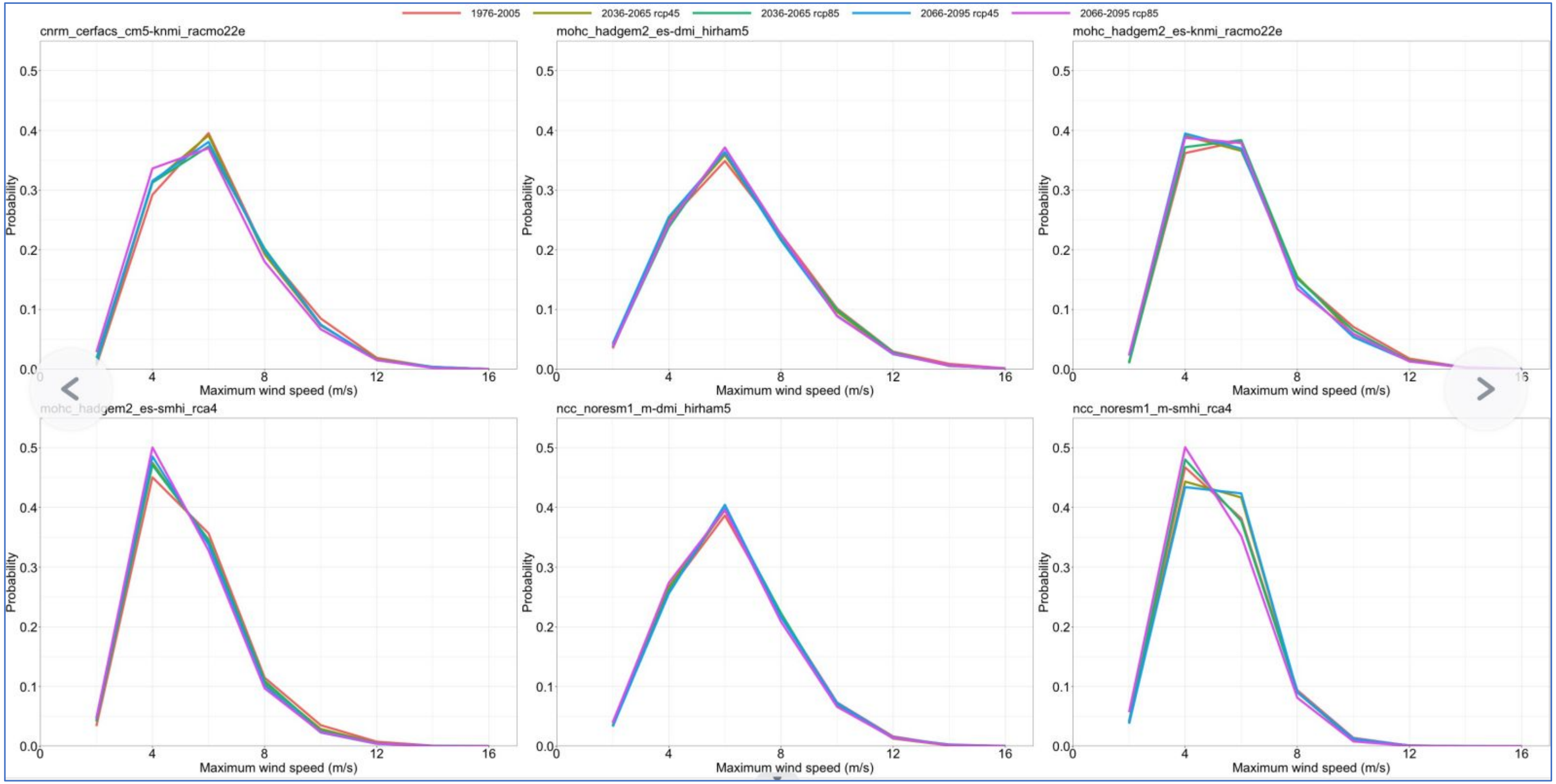
Results: wind speed distribution



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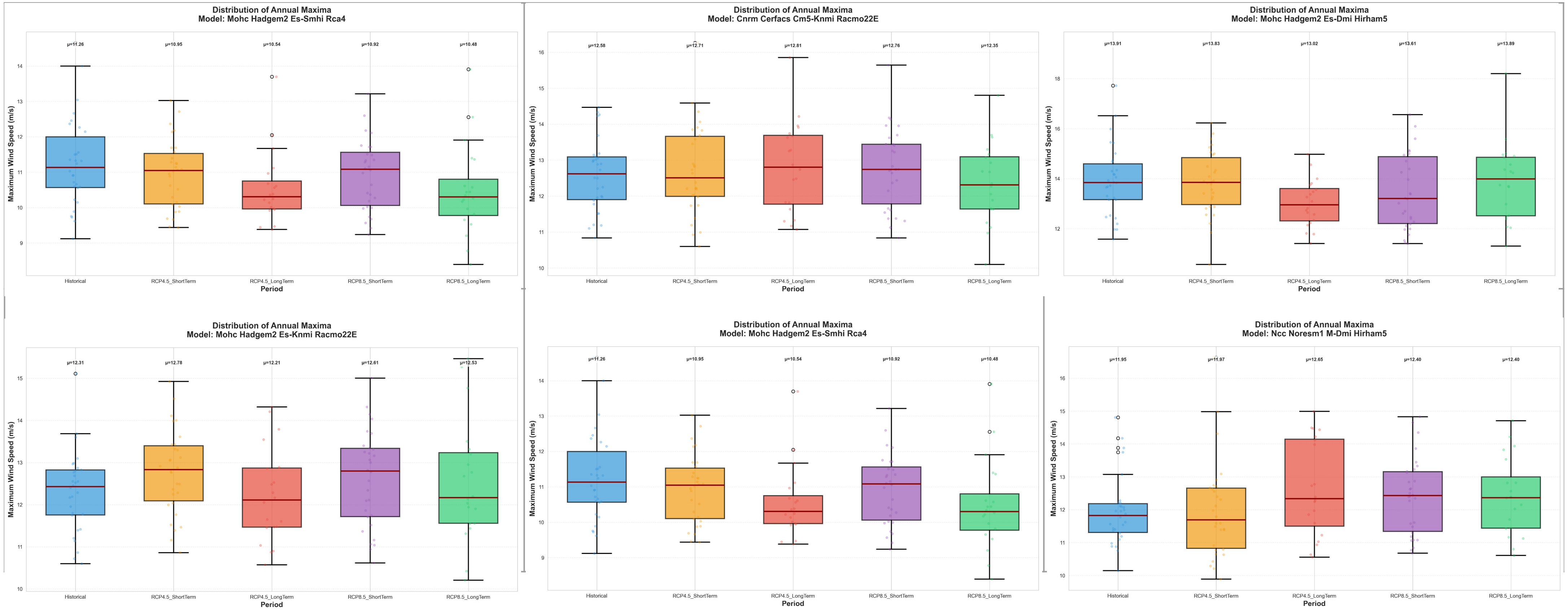
Annual maximum wind speed: raw data



- We cannot see a clear pattern and there is a lack of variability
- Extreme value analysis is affected by the outliers

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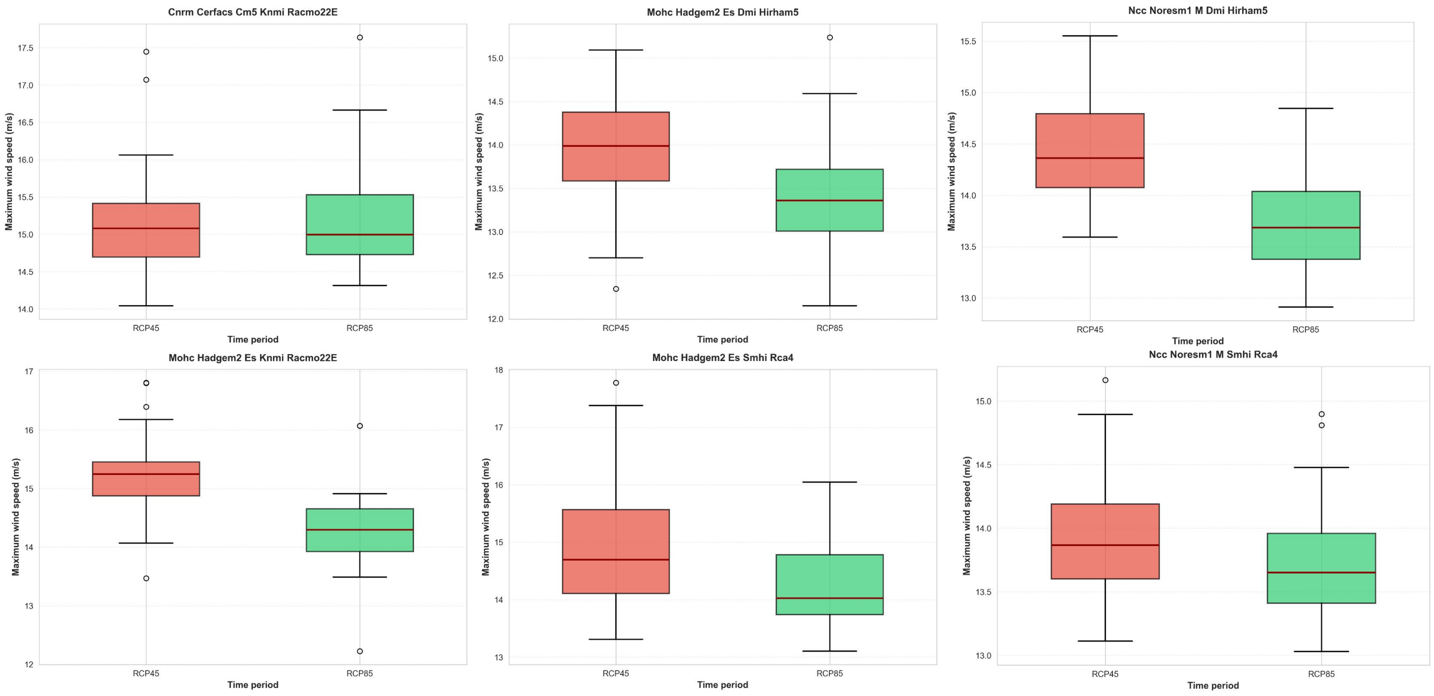
Annual maximum wind speed: bias corrected data



- Bias corrected have more extreme values

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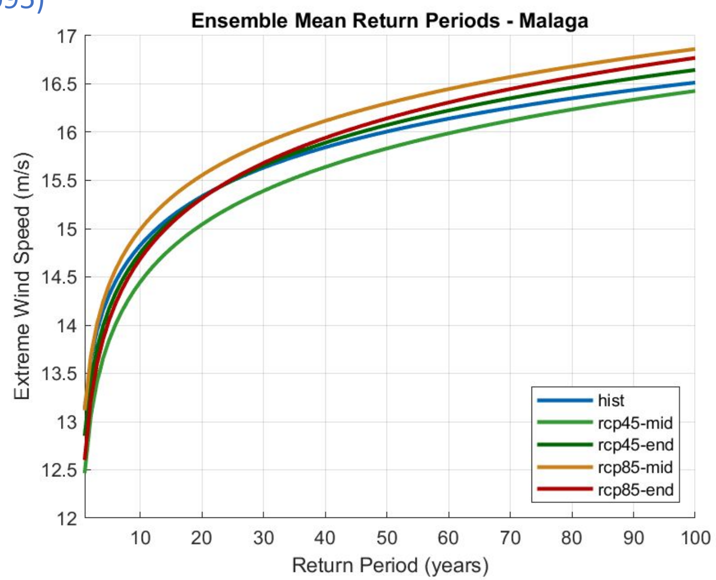
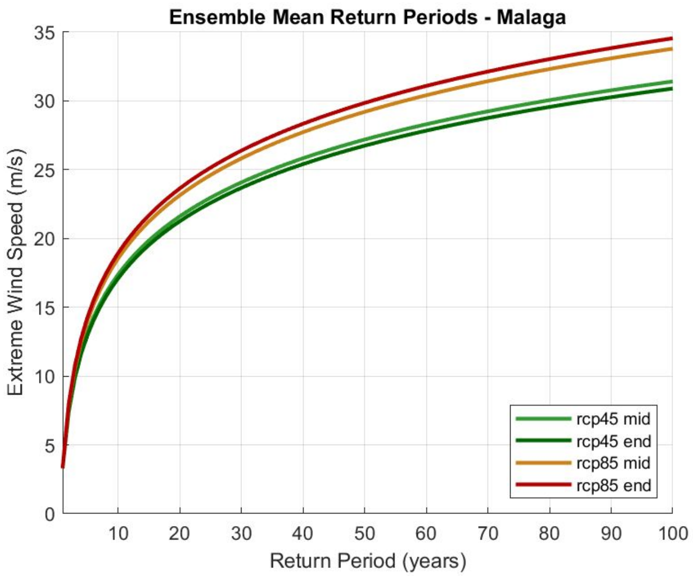
Return periods ensembles

Hist 1976-2005
Mid-century (2036–2065)
End-century (2066–2095)

Raw data (avg ensembles)



Bias corrected data



- Bias corrected data shows higher wind extremes because it is based on local data and can capture the local climatology
- More clear differences in the scenarios with unbiased data
- For a given return period, the wind is more extreme under RCP8.5

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Thank you!

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